grant degrees, but to grant them as a mark of success in regular and systematic courses of study, rather than in the display of hastily acquired, and, therefore, ill-digested knowledge. (3) To stimulate scholarly and scientific research by means of well-equipped libraries, laboratories, and other like apparatus, and by the institution of public lectures of an advanced character, like those of the Sorbonne and the College de France. The scheme drawn up by the Gresham Commissioners satisfies most of these requirements, and a *deus ex machina* in the shape of a Statutory Commission is all that is wanted to establish it.

So much attention has recently been given to the new treatment of diphtheria, that Dr. Roose's sketch of the history of the complaint, and the circumstances which tend to promote its spread, comes very opportunely. His description of the measures calculated to check the prevalence of the disease, and of the remedy lately introduced, is clear and concise, whilst the following statement, though commonly known in the scientific world, will remove the misapprehension that exists in the minds of a large section of the general public:—"Löffler and Klebs discovered the microbe of diphtheria, and studied its life-history; Roux and Yersin demonstrated that the bacillus was capable of evolving toxic material, and Behring crowned the edifice by discovering the antidote."

An address by Prof. G. W. Prothero, on "Why should we learn History?" contained in the *National*, would at first hardly seem to be a subject for comment in these columns. There is, however, much in the address worth noticing here, for Prof. Prothero shows that history, if not strictly speaking a science, may be taught in a scientific way. Let us briefly state his argument. There are many gaps in history, but in every science there is a lack of information on certain points. Even astronomy, the most exact of the sciences, has its dark spots, and there are shady places in evolutionary biology. Thus, so far as imperfection of knowledge goes, history and science only differ in degree. A greater difficulty, perhaps, is that the historian cannot employ experiments either to discover facts or to test observations; but here again it suffers in company with geology and other branches of natural knowledge concerned with the past. History is therefore not disqualified from being a science because it is not experimental. The infinite variety and extent of historical phenomena, and the presence of the human element are, however, "obstacles which, it must be allowed, check history on the threshold of science. If indeed the term science is to be restricted to the knowledge and application of general laws—if that alone is science which can foretell with certainty the occurrence of certain results—if science deals with no phenomena but such as can be exactly weighed and measured—then history is not a science at all. But this is surely to restrict science within too narrow limits. All sciences are not equally exact or equally capable of generalisation. . . . There is, in fact, a regular gradation from the sciences of abstract reason and mathematical formulæ, through the phenomena of the inanimate and the animate world to the world of man." But, *pace* Prof. Prothero, if history be granted a place among the sciences, it must be scientific in the ascertainment of its facts. Take the Black Death as an illustration. The vague and exaggerated statements of certain chroniclers of its ravages may be taken as evidence, or the more laborious process of searching the registers of the time may be explored. The difference is that one of the ways is scientific, while the other is unscientific. In the drawing of conclusions, also, "there is the same distinction between scientific and unscientific work as there is in the ascertainment of historic facts. For instance, Buckle, in illustrating his theory that national character depends largely upon food, attributes the weakness of the Hindoos to an almost exclusive diet of rice. A striking but misleading generalisation, for, as Sir H. Maine has pointed out, the great majority of the Hindoos never eat rice at all. . . . There is, then, a scientific way as there is an unscientific way of studying history. If treated one way, its results are guess-work and delusion; if treated another way, if industry, reason, and sober judgment are brought to bear, its results are in many cases matter of certainty, in many others matter of at least high probability. And, if we except the science of mathematics, what more can be said of any science?" The main object of Prof. Prothero's address was to show that historical study exerts considerable influence upon the mind and character. This is certainly the case, and if the student is trained on the lines indicated in the foregoing, intellectual results of the highest order must follow.

The great landslip which caused the formation of the Gohna Lake, Gurhwal, in the central Himalayas, has led Mr. W. M. Conway to write on "Mountain Falls" in the *Contemporary*. This catastrophe, however, is only used as a peg upon which to hang an account of the great Alpine landslip which buried part of the village of Elm, in Canton Clarus, thirteen years ago. The *Contemporary* also contains a metaphysical article by Emma Marie Caillard, in which cosmic and ethical processes are discussed, and Prof. Huxley's opinions on evolution and ethics are criticised. Prof. Huxley is also involved in a paper on religion and science, contributed by A. J. Du Bois to the *Century*. Another article for abstract philosophers is Prof. Seth's second paper on "A New Theory of the Absolute."

Sir Robert Ball contributes to *Good Words* another of his interesting—albeit superficial—papers on great astronomers, the subject being Sir John Herschel. *Chambers's Journal* contains the usual complement of chatty articles, among which we notice one on smoke absorption, descriptive of Colonel Dulier's patent system of removing the soot and sulphurous acid from the products of combustion, by treatment, before passage into the chimney, by both steam and water; and another on remarkable hailstorms.

A passing reference will suffice for the remaining papers on scientific topics. The result of prematurely releasing a chrysalis from its cocoon, a subject on which we published a letter by Dr. L. C. Jones in our issue of November 22 (p. 79), serves Mr. W. C. Wilkinson as the theme of a poem in the *Century*. St. George Mivart writes popularly on "Heredity" in the *Humanitarian*, his paper dealing chiefly with Prof. Weismann's speculations. A posthumous paper of Richard Jefferies' appears in *Longman's Magazine*, and Mr. Phil Robinson contributes a facetious paper on rattlesnakes to the *English Illustrated*. In addition to the magazines and reviews named in the foregoing, we have received *Scribner*, *Cassell's*, and the *Sunday Magazine*; but these do not contain any articles that can be commented upon here.

OYSTER CULTURE ON THE WEST COAST OF FRANCE.

AT the request of the Lancashire Sea-Fisheries Committee, I spent some time, last June and July, in investigating the various methods of shell-fish culture in use along the western coast of France from Arcachon in the south to Brittany in the north. There can be no doubt that there are extensive and flourishing shell-fish industries along the French coast, and one is struck very forcibly with the admirable manner in which the people seem to make the best of unfavourable conditions, and to take full advantage of any opportunity given to them by nature. Few places on any coast could look more desolate and forbidding than the vast mud swamps of the Bay of Aiguillon, and yet by means of the "bouchot" system many square miles of this useless ground have been brought under cultivation, and an industry established which supports several villages. Then again, the neat little enclosures along the beach at many places, carefully tended by the owners at low tide, remind one constantly of market gardening, and enforce the truth of the idea, long familiar to the biologist, and now beginning to be more generally recognised, that the fisherman should be the farmer, not the mere hunter of his fish, and that aqui-culture must be carried on as industriously and scientifically as agriculture.

In addition to industry and care on the part of the fisher-folk, women as well as men, the success of the shell-fish industries in France is largely due to the encouragement and wise assistance of the Government, especially in the regulation of general oyster-dredging and the reservation of certain grounds for supplying seed. The practical question—and one of enormous importance—is: Is there anything special in the conditions in France, either of the land or of the water, which would render their methods inapplicable to our more northern shores? I do not believe that the question can be satisfactorily and finally answered until some experimental cultures on a fairly large scale have been tried; but a consideration of the details and results of the French methods will at least give us some idea of which experiments are worth trying, and of the localities which might be cultivated with most prospect of success.

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[1] Abstract of a report, by Prof. W. A. Herdman, F.R.S., to the Lancashire Sea-Fisheries Committee.

The leading characteristics of French oyster culture are (1) that the whole is under the regulation and supervision of the State, concessions of ground being given to individuals or companies (*e.g.* at about 30 francs the hectare at Arcachon) for the purpose of forming oyster "parcs"; (2) that certain grounds are set aside or preserved as banks of breeding oysters to supply the spat; and (3) that the whole process of raising the spat, and rearing and fattening the oyster, is not carried on at one locality, but is subdivided and specialised, spat-production taking place best at one locality, such as Arcachon, and fattening for market at another, such as Marennes.

Two species of oyster are cultivated, *Ostrea edulis*, the ordinary rounded flat oyster of north-west Europe; and *O. angulata*, the elongated Portuguese oyster. The latter, although increasing in numbers in some places, and becoming of considerable commercial importance, is not so highly thought of as is *Ostrea edulis*.

There are now only two places on the coast of France where spat is produced in sufficient quantity to be of commercial importance. These are Auray, in the north, and Arcachon, in the south, and these two localities supply all the other oyster culture centres in France, and even export to other countries. One merchant I met at Arcachon told me that he had already sent eleven millions of oysters to London that season.[1] I visited in all about ten different oyster-culture centres; but as several of these showed nothing special, they need not be mentioned. The arrangements for the capture and rearing of spat were best seen at Arcachon, and for the further rearing and the fattening of the adults at La Tremblade and Marennes on the estuary of the Seudre. At Arcachon I was fortunate in enjoying the hospitality of the excellent Biological Station, which was established nearly thirty years ago by La Société Scientifique d'Arcachon, and which was made use of by Paul Bert in 1867 for his observations on the physiology of marine animals.

Arcachon presents remarkable facilities for the study of shallow-water marine forms, and is of great interest to the biologist, as well as to the ostreiculturist. Its vast inland sea (Bassin d'Arcachon), which is about 80 kilom. in circumference, contains at high tide about 15,000 hectares of area, and is, over the greater number of the channels, about 5 to 10 fathoms in depth, while two-thirds of the whole area dries at low tide. In the middle of the "bassin," and north of the town of Arcachon, is a small island, Ile des Oiseaux, and on the shores of this, and on various other flat shallow parts which are exposed at low tide, and which are called "crassats," are situated the oyster "parcs." Some of these areas are reserved by the State for the purpose of producing spat, a wise precaution, although some of the parqueurs think the State reservations unnecessary, as there are so many adult oysters over the ground that plenty of spat is sure to be produced. Certainly during the time of my visit, which was just when the free-swimming embryos were settling down, the water over the parcs seemed to be swarming with them, and the spat was making its appearance over all sorts of suitable submerged objects. The summer of 1893 was, however, a particularly good season, which the parqueurs attributed to the great heat. Probably calm weather and absence of rain during the critical period when the young oysters are free-swimming, and then settling down, has as much to do with a heavy fall of spat as the actual temperature.

The oyster reproduces at Arcachon between May and the beginning of July, and the young animal leads a free swimming existence for about a week before settling down as spat. The parqueurs examine carefully the condition of the spawn in the old oyster, and at what they consider to be the proper time (generally about the end of June) for catching the deposit of spat, they place their "collectors" in position. It is of importance that the collectors should not be put in the water too soon, as they are liable to become coated with slime and sediment, which will prevent the young oyster spat ("naissain") from adhering. The collectors are crates ("gabarets" or "ruches") of earthenware tiles, coated with a limy cement which gives them a whitewashed appearance. The tiles are like ordinary roofing tiles, about fourteen inches long by six inches at one end and five at the other, and half an inch in thickness. The cement with which they are coated is made of lime mixed with sea-water and a certain amount of sand, so as to form a creamy paste. Different proprietors use slightly different proportions of lime and sand. The process of coating ("chaulage") adds from one-sixteenth to one-eighth inch in thickness to each side of the tile. It has to be done with some care, so that the limy layer may be of the right nature, sufficiently strong and adhesive, and yet readily detachable when the time for "détroquage" comes, so that the young oysters may be removed from the tiles without injury, and without the necessity of breaking up the tiles, as used to be the case. By the present method the little oysters and film of cement can be flicked off rapidly by a skilled hand with a square-ended knife, and the tiles preserved for use again the following year. A dozen or more millions of these tiles are probably employed each year at Arcachon. The prepared tiles are arranged in alternating rows lengthways and breadthways inside cases made of strips of wood, so that the water may flow in readily between and around them. The cases of collectors I measured were about 6 feet × 2 feet and 3 feet in height, each holding 120 tiles arranged in ten layers. The alternating arrangement of the layers is intended to break up the currents of water as the tide runs through the "ruche," form eddies, and so give the young oysters a better opportunity of affixing themselves to the tiles. The tiles are all placed with the convex surface upwards, as it is very important that there should be as little opportunity as possible given for the collection of any fine sediment in which the young spat might be smothered. The arrangement of tiles above described is now considered the best at Arcachon. Various other arrangements have been tried, and may be suited to special conditions of bottom or depths of water.

I was very fortunate in seeing some of the tiles just after the young oyster spat had been deposited, and photographed such a tile covered thickly with the minute amber-coloured specks. There may be several hundred such young oysters on one side of a tile. During my stay at Arcachon I found that the temperature of the water varied from 74°F. to over 80° F., and the specific gravity from 1·022 to 1·024. However, it is known that no such high temperatures are really required for spat production, since, *e.g.*, Captain Dannevig has had an abundant deposit of spat in his pond near Arendal in Norway, where the July temperature of the water was only 63° F. To compare these with our own district, we find that in the same week of July 1893 the water off the south end of the Isle of Man was on the average about 60° F. with a specific gravity ranging from 1·025 to 1·026, while shore pools near the Biological Station at Port Erin, comparable as to exposure with the oyster parcs at Arcachon, reached as high a temperature as 76° F. Dr. Bashford Dean[1] and other authorities state as their opinion, that a low specific gravity is necessary for a good deposit of spat, but there is no unanimity on this point amongst the practical men at Arcachon (some of whom are keen observers, and are in the habit of taking the temperature and specific gravity).

After removal from the tiles, those young oysters which are not sold to "éleveurs" away from Arcachon are kept for another year or two in the parcs. They are placed at first in flat trays having a floor and lid of close galvanised wire netting, of about half-inch mesh, and these trays ("ambulances" or "caisses ostreophiles") are placed between short posts in the water on the oyster parc, so that the tide can run freely through them, supplying the oysters with food and oxygen. They measure about 6 feet by 4, and are 6 inches deep. They serve to keep the young oyster, during the early period of its life, out of the sediment, and they also protect it from its numerous natural enemies, such as the starfishes and crabs, which manage to suck or pick out the soft body, and whelks, such as *Purpura*, *Murex* and *Nassa*, which can bore a hole through the shell. The ambulances are constantly looked after by the oyster men and women, who come at low tide, when they are exposed, open the lids, and pick over the contents, removing enemies and impurities which may have got in, taking out any dead oysters, and rearranging those that are left, so that all may have a fair chance of obtaining food and growing normally. The young oysters grow rapidly in the ambulances, and soon have to be thinned out. The larger ones are removed, and if large enough are thrown into the open areas of the parc. In this way, by thinning out, rearranging, and adding fresh supplies, relays of young oysters in their first year may occupy the ambulances for eight months, although an individual oyster may only be in for a month or so.

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[1] Two-year olds, measuring 5 to 6 cm. across, cost at the rate of 12 francs per 1000, and somewhat older ones, measuring 6 to 7 cm., 25 francs per 1000. These prices include packing and carriage as far as Bordeaux, where they meet the steamer. On an average only 1 per cent. die on the journey. From the middle of March to the middle of April is the best time to send young oysters for stocking purposes to England. Before that it is liable to be too cold in England, and later it is too hot in Arcachon for transportation to be effected safely.

[1] Various important papers in Bulletin U.S. Fish Commission.

Eventually all the oysters not sold to éleveurs get transferred from the ambulances to the open rectangular areas, like little fields, which make up the rest of the parc. The low banks bounding these areas are formed of two parallel rows of close-set vertical bunches of the local heath, *Erica scoparia*, with the space between, a foot or more wide, filled in with masses of a tenacious clay obtained from the Ile des Oiseaux. Planks of wood and stakes, to strengthen the boundary, are also used in places, and at one corner a sluice is formed, so that the water at low tide may either be retained to a depth of 6 or 8 inches, or allowed to run off as required. About one million oysters can be accommodated in each little field, which is about at the rate of 125 to the square metre. Going thoroughly over a parc, partly in a boat and partly by wading, gives one an excellent idea of the extensive and profitable system of aquiculture practised at Arcachon.

Between neighbouring oyster parcs, and surrounding the "concessions" of the various proprietors, run lanes of water about 4 metres wide. These give ready access to the parcs, and can be traversed by the long gondola-like boats of the parqueurs. The lanes are bordered by rows of tall saplings with bunches of twigs left on. These are called "pignons." They keep waving in any slight breeze, and give a characteristic appearance to the scene. The oyster men declare that they are of use in frightening away fish, and especially the voracious ray *Myliobatis*, which might otherwise do great damage in the preserves. Possible depredations of another kind are guarded against by the "pontons," or large barges, moored at the corners of the parcs in which the "gardes des pêches" live.

Great numbers of the oysters bred and reared through their early stages at Arcachon are sent to Marennes and La Tremblade, in the flat district on both sides of the estuary of the Seudre, to be fattened in a *parc d'élevage*, and "greened" by feeding upon the diatom *Navicula fusiformis*, var. *ostrearia*. Wide canals from the estuary lead the sea-water inland, and supply the numerous "claires," which are merely shallow artificial ponds excavated in the clay and marly soil. In spring and early summer the muddy floor of the claire undergoes a good deal of preparation by digging, cleaning, draining, and exposure to sun and air, in order that later on, when sea-water is readmitted, at first in small quantity, it may be in what has been found by experience the most favourable condition for the growth of the desired kinds of lower algæ. These soon cover the floor with a dense green growth, which the éleveurs recognise as being of great importance to the nutrition of the oysters. Samples of the growth which I collected from the bottoms of several claires consisted of *Cladophora flavescens* and *C. expansa*, along with *Spirulina tenuissima* and a *Lyngbya* and little tufts of *Calothrix*, while a more detailed examination with the microscope shows that these plants are teeming with small animals and other forms of life, and nearly everything is covered with innumerable diatoms. Probably the larger green algæ, thought so much of by the éleveurs, are only of importance in oyster culture in providing points of attachment and shelter or favourable environment for the microscopic forms of life, and especially for the diatoms. It is well known that diatoms form a most important constituent of the food of oysters, and that the greenish blue tint of the celebrated Marennes oysters is due to the presence in the claires of enormous quantities of *Navicula fusiformis*, var. *ostrearia*, upon which the oysters feed. This form is found in our own fishery district in the estuary of the Dee (and probably elsewhere), although not abundantly; but it is probable that there are various other allied diatoms that would do equally well for rearing and fattening oysters on, and as a matter of fact the examination of the contents of an oyster's stomach shows that the food consists of a number of different kinds of diatoms as well as other minute organisms.

Altogether, all the evidence I was able to collect shows, I think, that the bottom of a claire is teeming with microscopic life, and that it is probably this rich feeding *alone* which is necessary in order to bring the oysters, in a very short period—a few weeks usually, sometimes ten days or a fortnight is sufficient—to the desired condition of fatness and flavour. The autumn and early winter months are said to be the best for fattening and greening.

I shall have to omit all reference to the industries at Pointe le Chapus, at the Island of Oléron, at La Rochelle, at Les Sables d'Olonne, and at Le Croisic—except a brief explanation of the basins of "dégorgement" seen at Le Chapus and elsewhere. These are shallow tanks, high up on the beach, with smooth bricked or tiled floors, so that they can be kept clean and free from mud. Their purpose is to enable the oysters taken fresh from the parcs and claires, and which naturally have some fine mud and food-matters of a decomposable nature clinging to them, both externally and internally, to lie for a few days in clean water, and so get rid of their impure mud and excreta before being packed up and sent off on a journey. The oysters also become accustomed in these basins, which can be emptied and filled with water periodically, to close their shells and stand prolonged exposure to air.

I do not see that the French shores are, in any important respects better fitted for shell-fish culture than some parts of our own Lancashire and Cheshire coast.[1] The deposits, both littoral and submarine, are, on the whole, much the same, the fauna, both macroscopic and microscopic, is scarcely appreciably richer, and although the temperature of the water is decidedly higher in the south—probably on the average about 10° F. higher in summer—I do not think that that is an essential condition, *so long as the winter temperature of our water does not get too low*. It would certainly be necessary, I think, to keep our oysters completely submerged during the winter months; but there are several places in the estuaries of the Dee and the Ribble, and in the Barrow Channel near Roe and Peil Islands, where "littoral" cultivation in summer might be combined with "bedding out" in winter—somewhat as is done at present with American oysters in the estuary of the Wyre, near Fleetwood. As to the other conditions—of bottom, of water, and of food, several places in the Barrow Channel and in the Dee estuary seem to me to be well fitted for oyster culture.

ENDOWMENT FOR SCIENTIFIC RESEARCH AND PUBLICATION.[2]

I.

TWENTY years ago Prof. Tyndall delivered in New York and in other cities of this country a series of lectures upon light. The last of the series was an impressive plea for a more thorough prosecution of original research in pure science; and incidentally, for the need of endowments to maintain it. I was fortunate in having the opportunity to listen to that remarkable course of lectures, and to that plea for science. Its impression has never left me. The impression was the deeper, because Tyndall set upon it the seal of self-denial. Some 30,000 dols., nearly the entire net proceeds of his lectures in the United States—money for which he undoubtedly had abundant use in his own affairs, or at least in the prosecution of researches in his own country, and which by all precedent and the example of other lecturers he would have taken with him—this he has given to the science of this country, endowing therewith, in 1885, three scholarships for the prosecution of original research in physics, one under the direction of Columbia College, one under Harvard, and a third at the University of Pennsylvania.

The truths uttered and the example set by this self-denying master have already many times borne fruit. The late President Barnard, of Columbia College, who was a warm supporter of Prof. Tyndall when here, bequeathed to Columbia upon his decease a few years since the sum of 10,000 dols. for the endowment of another fellowship for the encouragement of scientific research, upon substantially the same terms as those of the Tyndall scholarships. In other parts of the country there have been some other endowments for similar purposes. In the last year Columbia has also received 100,000 dols., the munificent bequest of Mr. Da Costa, for the establishment of the department of biology. Although this bequest is not primarily for the prosecution of original research, it is not restricted by hampering conditions, and will to some extent, it is hoped, admit of a direct and continuous support of the highest and most advanced studies.

The appeal made by Tyndall has been often renewed by

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[1] This, being a report to the Lancashire Sea-Fisheries Committee, is only concerned with localities within the Fishery District.

[2] Address delivered by Mr. Addison Brown, at a meeting of the Scientific Alliance of New York. (Reprinted from Smithsonian Report, 1892.)